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CASE STUDY

Management of a horizontal root fracture with a Titanium Trauma Splint

The Surgeon

Marga Ree DDS, MSc
Private practice limited to endodontics, Amsterdam, Netherlands

Marga Ree, DDS, MSc obtained her degree in dentistry from the University of Amsterdam in 1979 and completed her residency in endodontics in 2001. She is a popular speaker for dental and endodontic conferences, and has given over 300 presentations and hands-on courses in more than 30 countries all over the world. She is the primary author of many articles published in national and international journals and has contributed to several books on endodontics and restorative dentistry. From 1980 till 2020 she maintained a private practice in Purmerend, Netherlands, which for the last twenty years was dedicated to endodontics. She is presently working at a multidisciplinary dental practice in Amsterdam.

Introduction

Horizontal root fractures are frequently seen after dental trauma. The name is somewhat misleading, as most root fractures are not horizontal, but rather oblique. A more accurate term is therefore intra-alveolar root fractures.
Treatment can range from splinting and regular follow-up to root canal treatment in the cervical fragment and surgical removal of the apical fragment. The prognosis for intra-alveolar root fractures is generally good, provided the fracture is not located in the cervical portion of the tooth. These cervical fractures, located at or coronal to the alveolar bone margin, usually have a poorer prognosis because the mobile cervical segment is particularly susceptible to future teeth injuries. This article discusses the treatment strategy and the role of splinting in intra-alveolar root fractures.

Diagnosis and Stabilization

Radiographs from different angles are essential to obtain the clearest possible picture of the progression of the fracture(s). Even better is a CBCT scan, if available (Figures 1 and 2). Vitality tests are of limited value during the first few weeks after the trauma: an initially negative pulp test does not necessarily mean that the pulp will not heal. Root canal treatment is almost never indicated during the first appointment after the trauma.

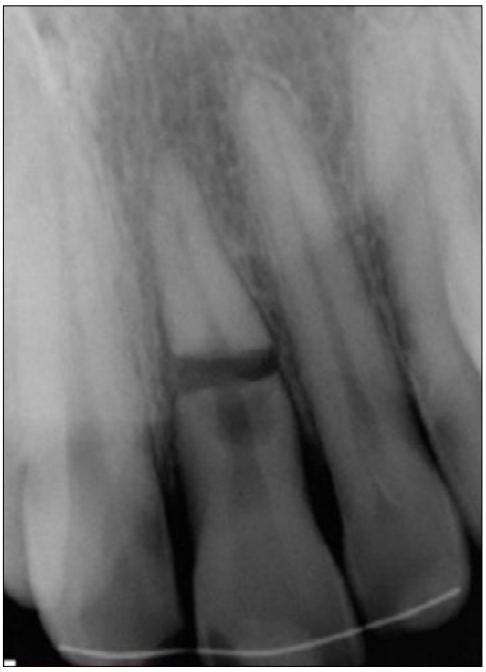

Figure 1: Conventional radiograph of an intra-alveolar fracture. A radiolucent area is visible beneath the fracture surface in the cervical fragment

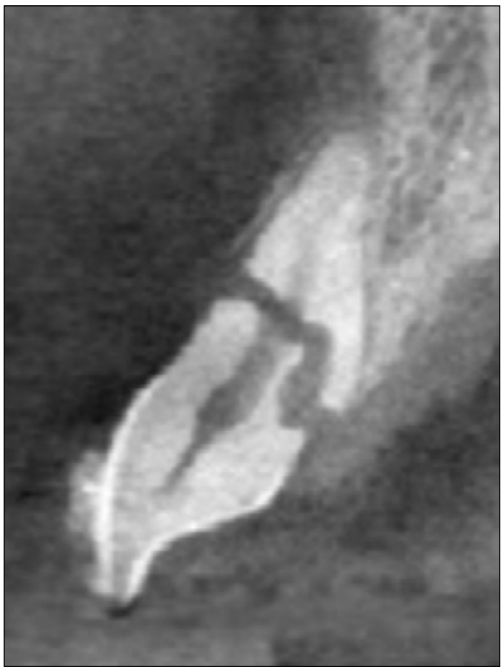

Figure 2: The same tooth, but a sagittal section of the CBCT

If the pulp in the cervical fragment does become necrotic, this will only manifest itself during follow-up appointments after several months. The mere absence of a positive pulp test is not an indication for initiating root canal treatment. During the clinical examination, the mobility and any displacement of the cervical fragment are also assessed. If the mobility is greater than 1 according to Miller's Mobility Index, a splint is indicated. If there is no increased mobility, a splint can be omitted.
If displacement of the coronal fragment has occurred, it is be repositioned. Ensure that the tooth is in proper occlusion and is not overloaded during proximal and lateral movements.

If indicated, a splint is placed for 4 weeks. If the fracture is in the cervical part of the tooth, it can be beneficial to extend the stabilization period, up to 4 months. The author prefers the Medartis Titanium Trauma Splint (Figure 3), because it is quick and easy to manipulate and apply[1], provides sufficient retention for the application of composite, has a high patient acceptance[2] and does not interfere with good oral hygiene. In addition, due to its low stiffness, it causes relatively little restriction of mobility, which has been shown favorable for healing of root fractures.[3–5]

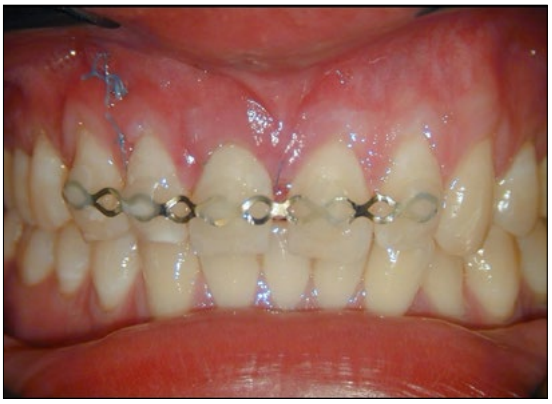

Figure 3: Titanium Trauma Splint applied to the maxillary front teeth

After one month, a pulp sensibility test has to be performed again and a radiograph is taken. It should be assessed for signs of bone loss or resorption. If the splint can be removed, it is helpful to first remove the composite from the affected tooth and then check its mobility. If the mobility has decreased, the splint can be removed. If not, the tooth is splinted again for one more month, in which case the splint only needs to be re-attached on the affected tooth.

Healing after an intra-alveolar fracture

In almost 80% of cases, favorable healing occurs through either fusion with hard tissue of the fracture surfaces (30%) (Figure 4) or interposition of soft tissue with or without bone formation (48%) (Figures 5-6). Research[6] has shown that pulp necrosis occurs in the cervical fragment in only 22% of cases (Figure 7). Signs of pulp necrosis can occur in the first 3-6 months after the trauma, sometimes even later. At least two symptoms must be present that indicate pulp necrosis, for example a repeated negative pulp test and discoloration of the crown, or a lateral radiolucency and a fistula. A negative pulp test alone is not an indication for root canal treatment. In most cases, the pulp in the apical fragment will remain vital and calcify. This apical part almost never requires treatment.

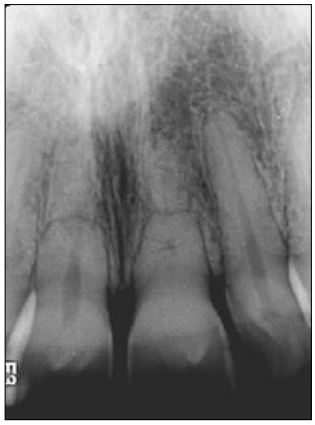

Figure 4: Radiograph of intra-alveolar fractures in 11 and 21 caused by an accident 25 years earlier. The patient is completely asymptomatic.

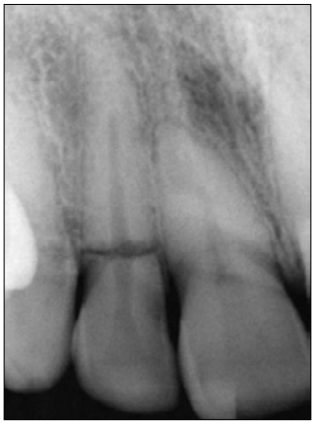

Figure 5: This intra-alveolar fracture in the 12 was caused by an accident five years ago. The tooth is slightly mobile, but functional and responds positively to pulp testing.

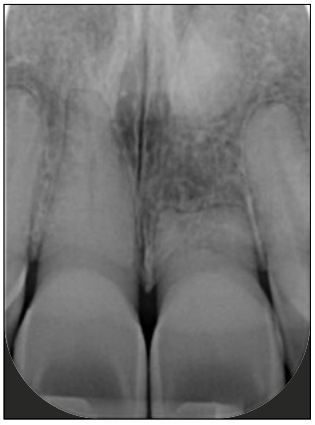

Figure 6: Nineteen-year-old root fracture. Both fragments are calcified and show surface resorption. The coronal fragment has undergone normal eruption, while the apical fragment has remained behind

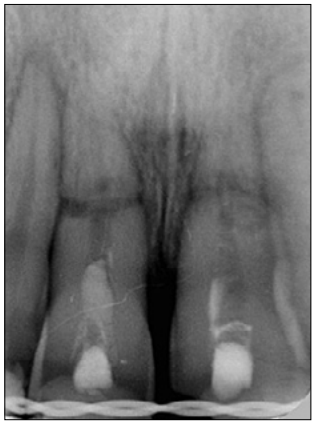

Figure 7: The pulp in coronal fragments of 11 and 21 has become necrotic, and granulation tissue is visible between the fracture surfaces.

If there is a pulp infection in the coronal fragment, root canal treatment is performed only in the coronal portion. Because there is a wide canal at the fracture surface, this root canal treatment should be considered an endodontic treatment in an immature tooth, using an apical plug of a calcium silicate cement for a good seal.

The Case

Patient History/Profile

A 12-year-old boy sustained a traumatic dental injury to his two central incisors (Figure 8-9). A dentist at the emergency service saw him for a consultation, took radiographs (Figure 10-11) and applied a splint (Figure 12).

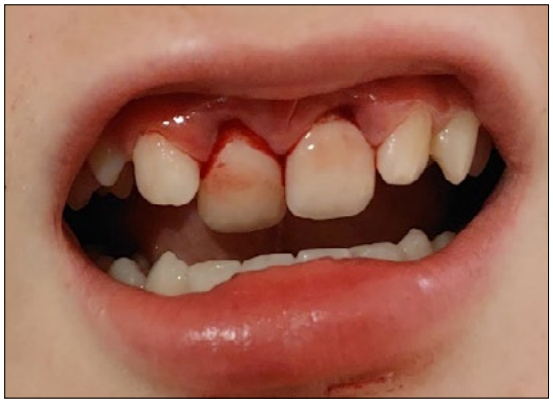

Figure 8: Frontal view after the accident

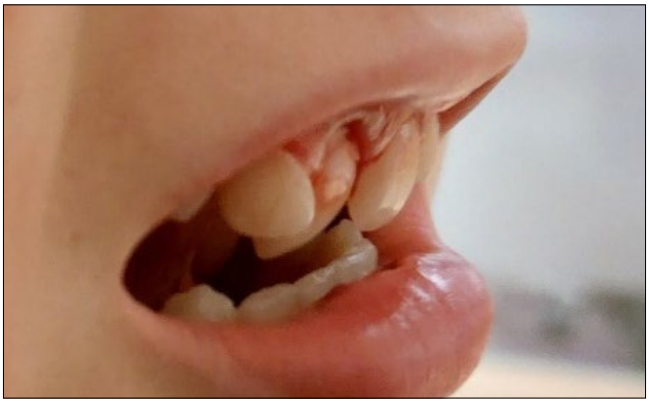

Figure 9: Lateral view of the displacement of 11 and 21. Note the displacement in palatal direction of both central incisors, but in particular 11

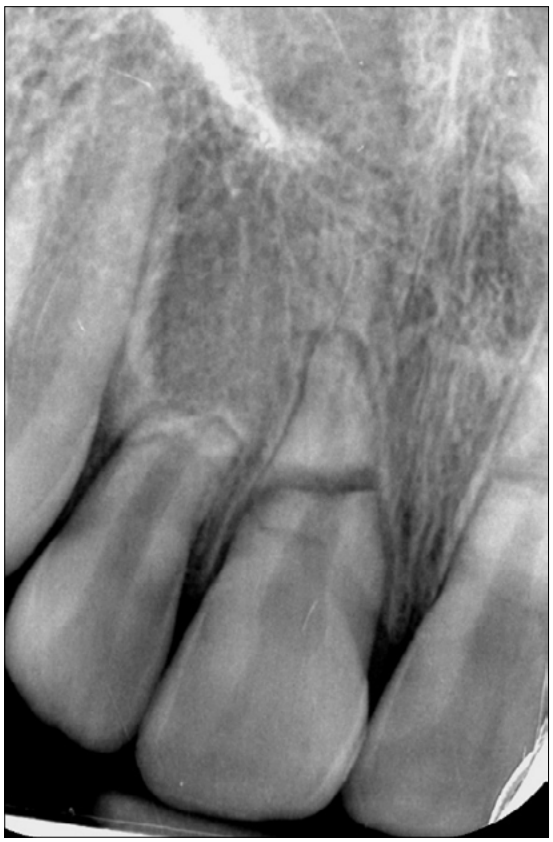

Figure 10: Pre-operative radiograph of 12 and 11. Tooth 12 shows severe apical resorption, not related to this dental injury

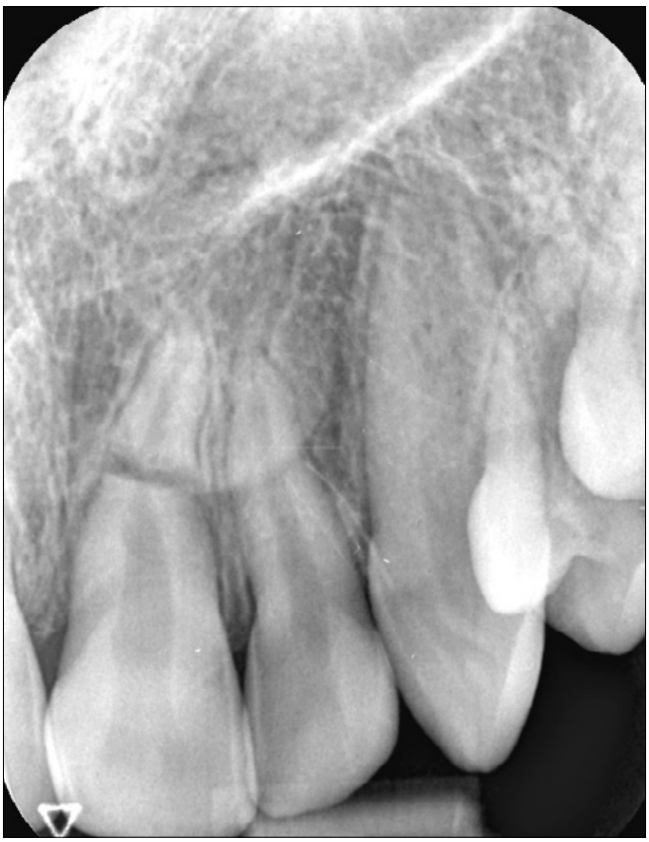

Figure 11: Pre-operative radiograph of 11, 12 and 13

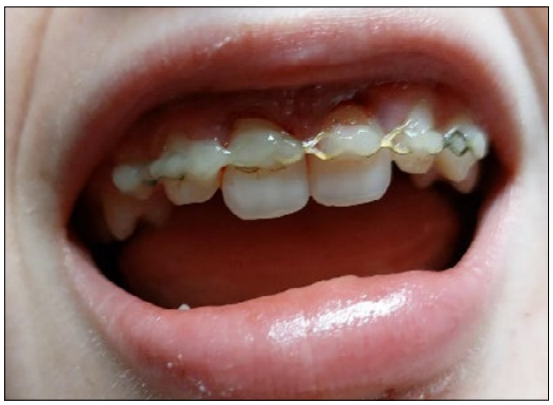

Figure 12: Clinical picture immediately after placement of the splint.

Unfortunately, the patient noticed that he was not able to close his mouth properly after the splint application, because the teeth felt “too high”. In addition, it was painful to bring the teeth together. He went to his family dentist the next day, who referred him to our practice. We saw him 2 days after the accident took place. After oral examination, it appeared that the palatal surfaces of 11 and 21 interfered during occlusion and articulation. It was decided to take a CBCT for further diagnosis (Figure 13-15). It was clear that the coronal fragments had not been repositioned properly, and the splint was loose on tooth 21 (Figure 16), so it was decided to remove the splint and try to reposition the coronal fragments again.

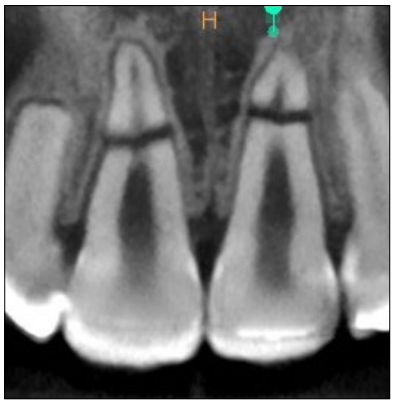

Figure 13: Coronal slice of the CBCT of 11 and 21

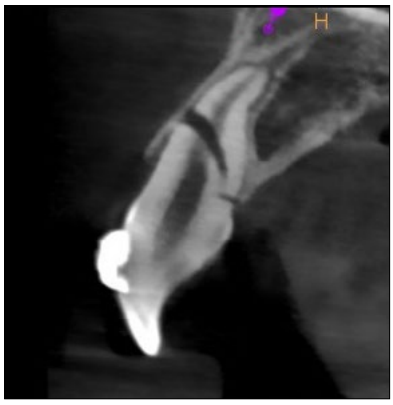

Figure 14: Sagittal slice of the CBCT of 11

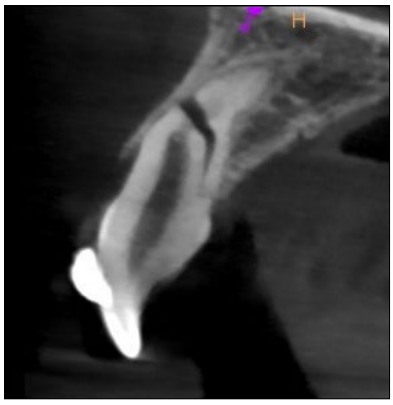

Figure 15: Sagittal slice of the CBCT of 21

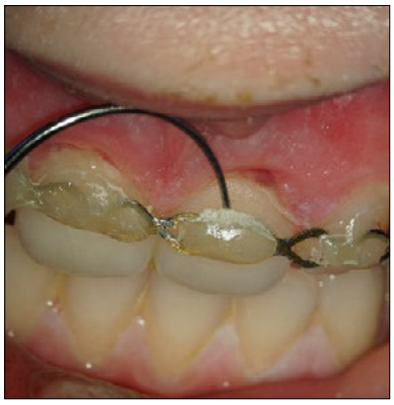

Figure 16: A probe shows the space between the labial surface and the splint

Surgical Treatment

Removing a splint is a procedure that should be carried out carefully, to avoid removing sound tooth structure.

Steps for removing a splint (see first part video: https://medartis.com/q/20/6324f1fa)

1. Use a retractor such as an OptraGate (Ivoclar) to retract patients' cheeks and lips and provide unobstructed view
2. Use magnification
3. Use a coarse diamond bur in a highspeed handpiece with sufficient coolant to remove the bulk of composite, until the golden appearance of the TTS turns silver
4. Gently detach the splint from the composite using a scaler or pair of tweezers
5. After the splint has been removed, continue to remove the remaining composite with a coarse diamond bur in a highspeed handpiece
6. The last layer of composite can be easily removed using a round bur without water spray. The surface of the tooth should be dried with the air-water syringe continuously, to distinguish the composite from the enamel surface
7. Another way to distinguish composite from enamel is to use a Fluorescence-aided Identification Technique (FIT)[7–8] with an UV light source. Dental resin composites have different fluorescence properties than enamel and dentine when illuminated with a wavelength of approximately 400 ± 5 nm
8. Polish the enamel surface with polishing burs and wheels

After splint removal, a gentle pressure was applied using a finger to check whether the coronal fragments could be moved in an apical direction. Then the buccal surfaces were acid-etched, and an adhesive was applied. Subsequently, the TTS was applied to the adjacent teeth with a flowable composite, and with gentle finger pressure, both central incisors were repositioned one by one in a more apical direction (see second part video: https://medartis.com/q/20/6324f1fa). Immediately after re-attaching the splint to 11 and 21 (Figure 17), the occlusion was checked.

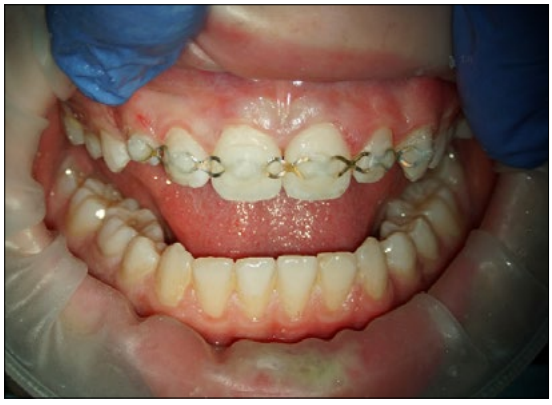

Figure 17: Clinical picture after repositioning of 11 and 21 and application of a TTS

Postoperative treatment

A post-operative radiograph showed that there was a significant difference in relation to the pre-operative radiographs regarding the proximity of the fracture surfaces (Figure 18). After 4 weeks, the splint was removed, in accordance with the guidelines of the internationally recognized Dental Trauma Guide, https://dentaltraumaguide.org/

Both incisors were stable and mobility was within normal limits (Figure 19).

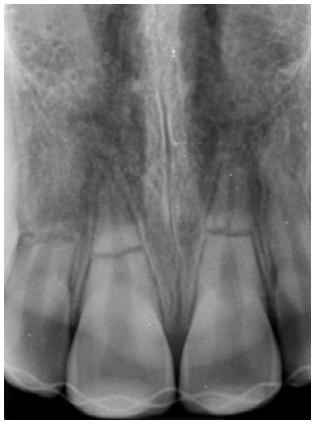

Figure 18: Post-operative radiograph showing that the space between the fracture surfaces has decreased

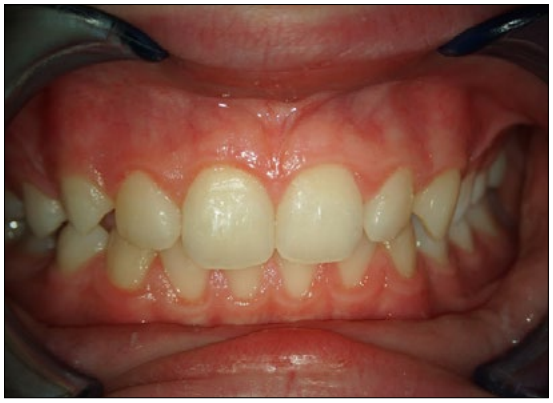

Figure 19: After removal of the splint

Teeth 11 and 21 were monitored closely, and at some point, it was decided to start root canal treatment in 11 (Figure 20), because there were several signs and symptoms (negative response to pulp tests, discoloration, sensitivity) indicating that the pulp in 11 had become necrotic. After instrumentation and disinfection of the coronal fragment of 11, a dressing of calcium hydroxide was applied for a couple of weeks. Root canal treatment was finished by placing a plug of Root Repair Material Putty (a calcium silicate cement) in the coronal fragment (Figure 21), followed by a composite build-up (Figure 22). In tooth 21, there was a positive response to pulp tests and no other symptoms. Mobility in all front teeth was within normal limits.

At the 1-year follow-up, the patient was asymptomatic, and both central incisors were in full function and showed no signs of infection, resorption and bone loss (Figure 23).

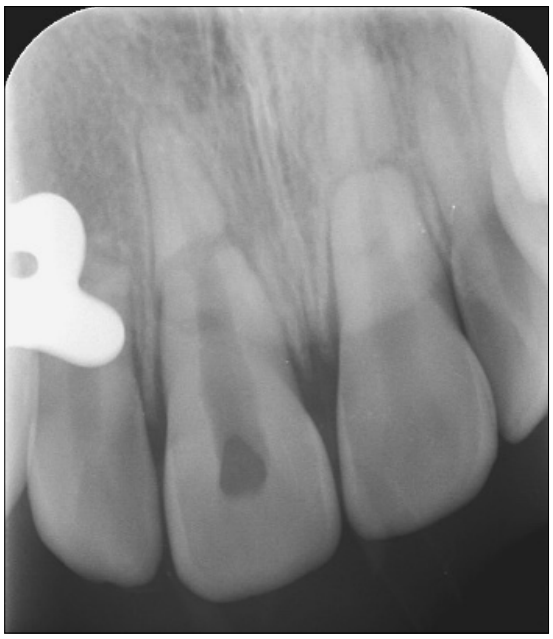

Figure 20: Pre-operative radiograph of tooth 11 after the patient became symptomatic

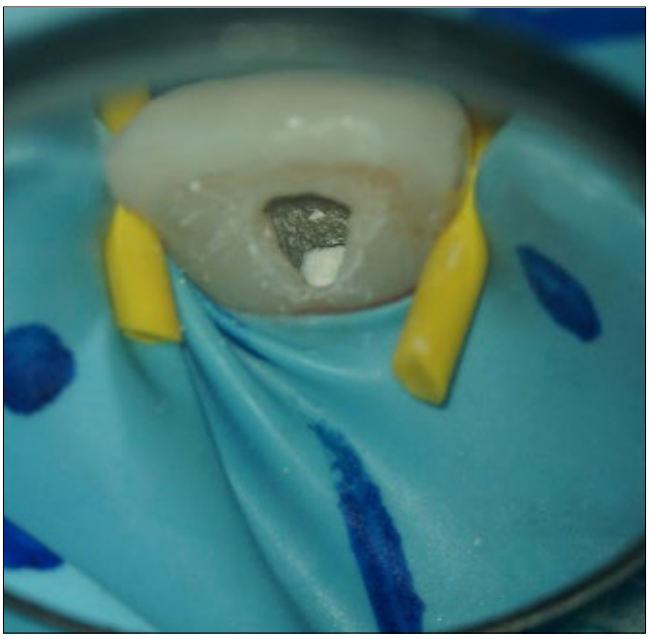

Figure 21: An apical plug of a calcium silicate cement, RRM Putty (Brasseler)

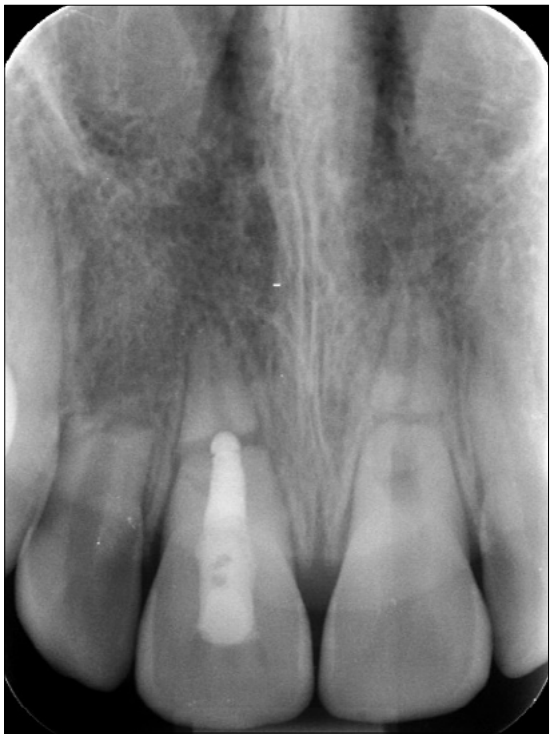

Figure 22: Post-operative radiograph after finishing the root canal treatment in the coronal fragment and composite build-up

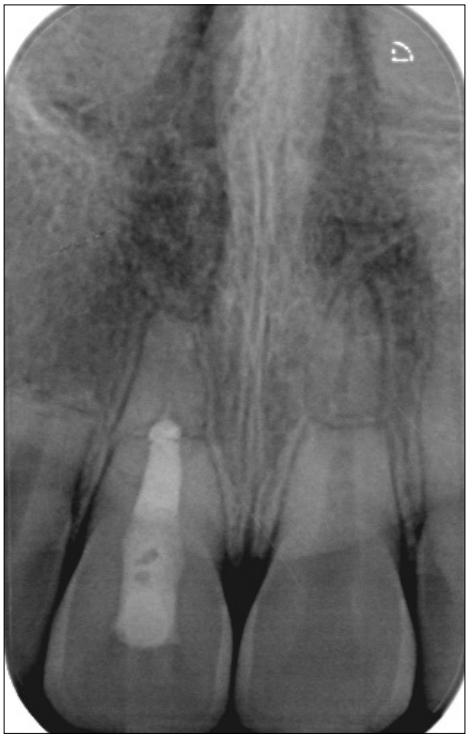

Figure 23: 1 year-follow-up radiograph

Conclusion

Intra-alveolar root fractures, if treated properly, have a good long-term prognosis. Stabilization with splinting and regular follow-up is generally indicated. If the pulp in the coronal fragment does show signs of pulp necrosis, a root canal treatment in the coronal portion is indicated, with the same guidelines as for an immature tooth with a wide-open apex. The pulp in the apical portion will calcify in most cases, and this fragment almost never requires treatment. Cervical fractures have a poorer prognosis, but it is worthwhile to leave the splint in place for a longer period (up to 4 months) and then reassess the prognosis.

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